

MEETING XIII BEVATRON RESEARCH CONFERENCE
March 23, 1954
4 PM Auditorium, Bldg. 50

Warren Chupp: Target Area Modifications

The following modifications are planned to facilitate greater usefulness of available target space in the west tangent tank.

1. A 3/32" x 6" x 106" aluminum window is to be added to the outer radius tank wall.
2. One 12" x 6" air lock is to be added on the inside centerline of the re-entrant section on the west tangent tank.
3. Two 24" x 30" openings are to be cut on the beam centerline in the top of the west tangent tank, one at each end. These openings will accommodate photographic plate wells of various kinds and also a large air lock that is being designed.

It is suggested that any other modifications to the target area be presented to E. Lofgren as soon as possible so that the modifications can be programmed with respect to operations. The same general policy holds for target location, viz:

- a) Small targets - allocations in west tangent tank
- b) Large targets - allocations in south tangent tank

William Wenzel: General Purpose Magnet

The design of two general purpose magnets is in the final stages. Copper for the coils will be ordered soon. The characteristics of these magnets are tabulated below:

Magnets	Coil Size (Inches)	Maximum Field (Kilogauss)	Available Aperture (Inches)	Power (KW)
2-pulsed	4 x 8	20	12 x 4	522
2-dc	4 x 4	13.5	20 x 4	350
1-pulsed	4 x 4	20	20 x 4	522
1-dc	4 x 8	21	12 x 4	350

Glen Lambertson: Bevatron Magnetic Field

GENERAL

Results of magnetic field measurements on the Bevatron are reported. Some of the details and compromises in design of the magnet are discussed.

The pole tip configuration in the 1 x 4-foot aperture nominally $n = 0.6$ has been cut to a mechanical slope of 0.63. The laminated pole tips have protruding ears which modify the fringing field at low magnet currents to provide the widest possible

aperture at injection. These ears are slotted so that they saturate and at intermediate field values become ineffective. This design represents a compromise between maximum useful field width and maximum obtainable field at peak current.

The pole tips contain 21 pairs of pole face windings which can be separately energized to allow small local field perturbations. Some of these windings are self-excited to shape the field at injection. Others are available for increasing the high field aperture.

The presence of fringing fields in the straight sections between quadrants is considered in defining for these regions an effective length given by:

$$\text{Effective magnetic length} = \frac{1}{\bar{B} \text{ at mid-quadrant}} \quad \text{Bdl at constant radius}$$

According to this definition, the magnetic length of a quadrant may vary with field strength. To compensate for the amount that the effective magnetic length of the quadrant is different from the 90° mechanical length, the particle orbit center is displaced from the quadrant center and some loss of useful aperture results. The end sector pole tips of each quadrant have been cut back $5 \frac{1}{2}$ inches as an attempt to bring the magnetic length more nearly in agreement with the quadrants' mechanical length.

To insure that iron samples would not introduce an azimuthal harmonic perturbation in the magnetic field, a random mixing schedule was followed in the assembly of magnet iron.

MAGNETIC MEASUREMENTS

The following magnetic measurements were made:

1. Logarithmic field gradient n and field B at radial 3-inch intervals within the the 4-foot aperture as a function of magnet current.
2. Effective length of quadrants as a function of magnet current.
3. Median surface, i.e., locus of points where there is zero radial component of flux density.
4. Fringe field contours at nominal peak field
 - a. West tangent tank
 - b. Field versus radius beyond the pole tip up to the magnet yoke
5. Effect of pole face windings at nominal peak field.

The dynamic field was measured by integrating Φ signal from specially constructed pickup coils. Appropriate electronic equipment was constructed to program the 300 to 16000 gauss presentation of information on one oscilloscope display, which was photographically recorded. Residual field was measured separately and added to dynamic field to obtain the total field behavior.

The average value of B was measured at each current marker at a limited number of points in the magnet. The spatial variation of the average B and the logarithmic field gradient were obtained from field difference measurements using balanced pairs of search coils.

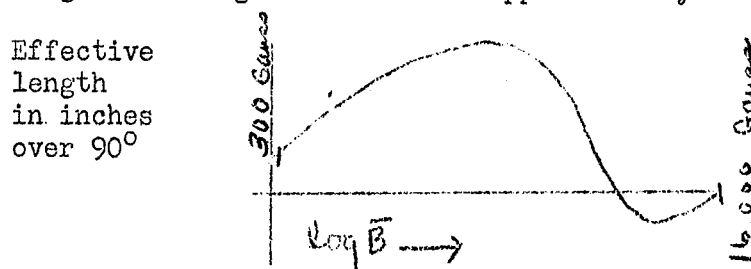
The median surface was located by adding radial components of the residual field and of the pulsed or dynamic field. Special vertically suspended coils were used in connection with the integrator in monitoring.

A. Average field versus current

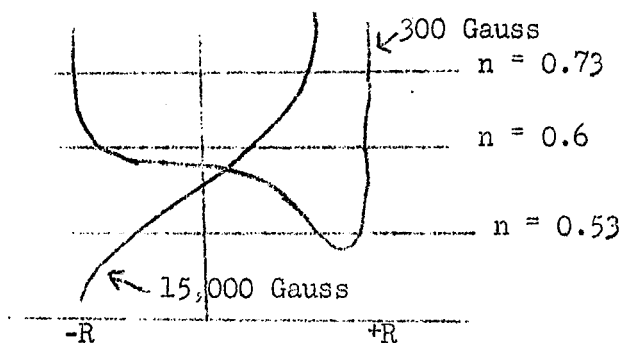
The measured field at gap center is in good agreement (3%) with $1/7^{\text{th}}$ scale data. The initial rate of rise is of the order of 3 gauss/ampere at 18 KV magnet voltage. The nominal field at $8\frac{1}{3}$ kiloamperes was 15,532 gauss. At 9 kiloamperes the field increases to only $\sim 16,000$ gauss as saturation effects reduce the rate of rise to $\sim 3/4$ gauss/ampere.

Measurements of magnetic field in the separate sectors showed that differences were typically within 0.2% for all currents. No coherent variations greater than 0.2% were apparent at the two central sectors. The field in these sectors was $5\frac{1}{2}$ gauss higher than the average field. This effect may be due to the eddy current distribution, as the vacuum tank geometry is different at these points. Pole base windings were connected for self excitation to correct this anomaly; measured results show the correction removed the inhomogeneity.

The maximum error in quadrant length is of the order of 8 inches. The variation of effective length with magnetic field is approximately as follows:

B. Variation of n with radius

The logarithmic field index is a function of the space coordinates and the magnetic field. The radial variation for extreme values of field appears approximately as:

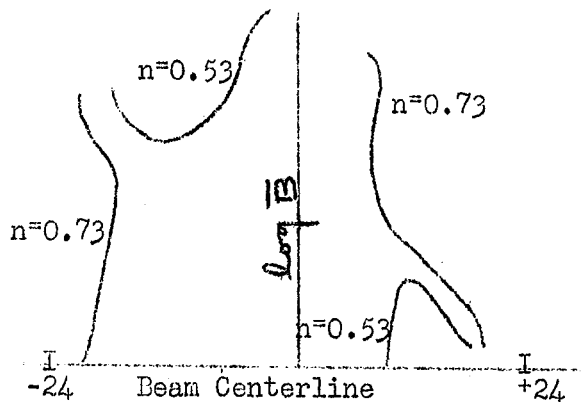


The useful limits of good field, as approximated by L. Smith are $0.53 < n < 0.73$

Below $n = 0.53$, resonance occurs between the vertical and radial oscillations. Above $n = 0.73$, resonance can occur between the radial oscillations and $1/2$ the RF driving frequency.

A coherent ripple in n is observed with radial position, which correlates with the change in width of the laminated pole tips. This is the presumed cause.

The available width of field, as defined by limiting values of n , appears somewhat as follows.



The injection field, when corrected with self excited pole face windings, is of the order of 44 inches.

Without correction, the useful width of field at 15,000 gauss is approximately 8 inches. Pole face windings can be expected to increase this width a few inches if necessary at the expenditure of approximately 500 KW of power.

C. Median Surface

If the position of the median surface is not constant with azimuth or radial position, oscillations may be excited to cause beam loss. Measured results show the median surface does not deviate more than 1/2-inch from the geometric median plane. The deviations that were observed were, from first appearances, random.

D. Pole face windings

The effect of exciting single pole face winding pairs was measured at 15,000 gauss. The results show an effect very similar to what one would calculate considering the iron as infinitely permeable.

E. Fringing fields

The field was measured at a matrix of points in the midplane in the west tangent tank at nominal peak field. A contour map will be available on completion to interested parties. Linear extrapolations within approximately 10% from the measured values will not introduce more than a few percent error.

F. Miscellaneous

The residual field is approximately 33 gauss but varies with pulse amplitude. Dependence upon inversion voltage amplitude and waveform was not measured. After a fault, the main field dies exponentially and leaves a residual field of 45 gauss. This effect is erased in 3 - 4 normal magnet pulses.

Eddy currents contribute about -27 gauss to the dynamic flux density. A change in rate of rise of current will alter the magnitude of this effect -- a consideration in operating at changing magnet voltages. The field measurements were made with the nominal 18 KV of magnet voltage.

Copies of pertinent magnetic field data are available to interested parties.

Summaries: Harry Hoard
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